

# Measurement of Respiratory Morbidity in General Practice in the United Kingdom During the Acid Transport Event of January 1985

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The Weekly Returns System of the Royal College of General Practitioners was used to assess the effect on respiratory illness of the acid transport event that occurred during January 1985. The pollution event, as assessed by SO<sub>2</sub> and smoke levels measured at pollution monitoring stations within and without the affected area showed only modest rises in SO<sub>2</sub> levels, which were less than levels that occurred 4 years earlier. January is the peak time of year for reporting of acute respiratory episodes, and the minor increase in pollution was not reflected in any rise in respiratory morbidity, both for all ages and for different age bands. There was a rise in rates for children up to the age of 14, but this was seen each year and in both polluted and nonpolluted areas. This was probably due to children returning to school after the winter vacation and the subsequent spread of viral infections. The limitations of the two data sets in this analysis are discussed, including the relative insensitivity of weekly data in picking out a short-lived event, the distribution of the practices and pollution monitoring stations, and the effect of the extreme cold weather and the coal miners' strike on domestic coal burning during this event.

## Introduction

During January 1985, a pollution event involving the accumulation of sulfur dioxide (SO<sub>2</sub>) occurred in western Germany (1). The pollution cloud moved westward over the Netherlands to the United Kingdom. The weather conditions were severe in the UK at the time, the mean temperature for January being 2 to 3°C lower than the 1951-1980 average. There had been widespread snowfall, heaviest in the southeast. The pollution cloud, under the influence of a temperature inversion and a blocking high pressure system over Europe, reached the UK around January 16. A recognizable but small rise in SO<sub>2</sub> was recorded over the eastern side of the UK, which subsided within a week.

Sulfur dioxide can induce airway narrowing in asthmatic patients (2) and has been implicated in

increases in mortality and morbidity from respiratory disease in past pollution episodes. The London Fog Incident of 1953 (3), where the co-existence of SO<sub>2</sub> with particulate pollution from domestic coal fires caused a huge increase in mortality, led to government legislation in the UK governing airborne pollution, the Clean Air Act (1956) (4). Since that time, the amount of total suspended particulates (TSP) in the air in the UK has considerably decreased, as has SO<sub>2</sub> emission, in the latter case, by nearly fourfold from an average daily value of 150 µg/m<sup>3</sup> in 1962 to 40 µg/m<sup>3</sup> in 1984.

Mortality from respiratory disease has declined since the Clean Air Act, notably in those patients dying from chronic bronchitis/chronic obstructive airways disease (5). Mortality was an effective measure of the effect of the pollution episode in London in 1952, where the environmental insult was great. For lesser insults where mortality may not be significantly affected, morbidity must be measured to detect any effect. Measurement of respiratory morbidity is not without its difficulties, and a largely untapped source of such data is the Weekly Returns System of the Royal College of General Practitioners Research Unit (6,7). This Unit collects data covering an at-risk population of

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about 200,000 spread over the UK and reports weekly numbers of various illnesses, including acute respiratory conditions ranging from the common cold to acute asthmatic episodes. The Air Pollution Unit of the Warren Spring Laboratories has a network of nearly 600 pollution monitoring stations spread throughout the UK and routinely monitors  $\text{SO}_2$  levels and black smoke. The aim of this study was to use these two data sources to assess whether or not the acid transport event of January 1985 produced a recognizable increase in acute respiratory illness in the affected area of the UK, and if weekly levels of  $\text{SO}_2$  and smoke correlated with acute respiratory episodes during the three winter periods of December to February 1983–1984, 1984–1985 and 1985–1986. We present here the result of a preliminary analysis of these data.

## Methods

### Morbidity Data

The Royal College of General Practitioners Research Unit collates weekly returns from approximately 40 general practices in the UK, comprising about 100 general practitioners and covering an at-risk population of approximately 200,000 (6,7). There is a slight variation in the population from week to week of about 5% because of nonreturns or from changes in individual practice populations. The system was originally set up to follow infectious diseases such as measles, whooping cough, and epidemic influenza as they occur in the community.

Among the diagnostic rubrics are a number of conditions affecting the respiratory tract ranging from the common cold to pneumonia (Table 1). No attempt is made to confer diagnostic guidelines upon the contributing general practitioners so the resulting data cannot be used for true incidence or prevalence data. However, as the inter-general practitioner diagnostic variability is consistent from year to year, the data are valid for following trends. Detailed data are available from the early 1970s and are available by sex or by age band (0–4, 5–14, 15–44, 45–64, and 65+), but not by both age and sex together. The age distribution of the population at risk is given in Table 2. The rates are given per 100,000 population at risk. The returns are made weekly; daily data are not available. For the purposes of this study, only those practices recording in the year of the pollution episode and in the 2 comparator years were included in the analysis, giving a total of 33 practices and an average at-risk population of 187,800 over the 3 years. For this study, rates for all the respiratory diseases listed in Table 1 were summed and considered together as total respiratory disease (TRD), as there is no intuitive reason why any specific part of the respiratory tract should be spared the effects of inhaled pollutants, and as there were no strict diagnostic guidelines given to the general practitioners. Separate analyses were also made for acute bronchitis

**Table 1. Respiratory illnesses covered by the Weekly Returns System.**

Common cold
Flulike illness
Tonsillitis
Sinusitis
Laryngitis
Epidemic influenza
Pneumonia
Pleurisy
Acute bronchitis
Acute asthmatic episode

**Table 2. Age distributions of the population at risk covered by the Weekly Returns System during the three periods of study.**

Age, years	Area <sup>a</sup>	1983/1984	1984/1985	1985/1986
0–4	P	5,960	5,925	6,525
	N	4,384	5,194	5,209
5–14	P	10,216	13,804	13,434
	N	10,600	11,843	11,021
15–44	P	45,252	46,825	48,118
	N	33,505	40,844	38,512
45–64	P	19,132	20,970	20,819
	N	17,339	20,529	19,263
65+	P	14,219	14,406	14,601
	N	12,419	14,271	13,320
All ages	P	99,668	101,931	103,566
	N	78,246	92,681	87,326

<sup>a</sup>P, polluted; N, nonpolluted.

and acute asthmatic episode because of the recorded past effects of inhaled  $\text{SO}_2$  with respect to these conditions.

### Pollution Data

The Air Pollution Division of the Warren Spring Laboratories gathers and analyzes data from nearly 600 pollution monitoring sites throughout the UK. Certain sites are used for specific purposes, so for this study 164 of the basic urban sites were selected. Daily measures of black smoke using a reflectance method and  $\text{SO}_2$  ( $\mu\text{g}/\text{m}^3$ ) using an acidity method were made, and the data for this study were averaged to give the average daily value for each week. Smoke concentrations were calculated using the British Standard Smoke Calculation Curve and were expressed as micrograms per cubic meter.

### Period and Areas of Study

An initial analysis of the acid transport event showed that the pollution cloud appeared over the eastern/central parts of the UK on Wednesday, January 16 (1). Fortunately, the weekly returns system runs from Wednesday to Tuesday, so the period of pollution (as far as the UK was concerned) occurred completely within a 1-week period of morbidity data acquisition. The area that appeared to be maximally affected by the pollution cloud is shown in Figure 1. We had to decide on a maximal affected area, accepting



FIGURE 1. Distribution of the 33 general practices involved in the Weekly Returns System showing the polluted and nonpolluted areas during the acid transport event of January 1985.

that the adjacent edge of the nonpolluted area would show an increase in  $\text{SO}_2$  and smoke that might affect the overall figures for the nonpolluted area, hopefully only to a small degree. Within the polluted area there were 16 general practices with an average at-risk population over the period of study of 101, 720 and 90 pollution monitoring stations. The comparable figures for the unpolluted area were 17 practices, an at-risk population of 86,085, and 74 pollution stations. Data were analyzed for the 4 weeks prior to the week of the pollution event in the winter 1984–1985, for the polluted week itself, and for the following 4 weeks. The equivalent periods from the winter before (1983–1984) and the winter following (1985–1986) were taken as the comparator years.

## Analysis

Morbidity data were analyzed for all ages and for each age band for total respiratory disease, acute bronchitis, and acute asthmatic episode. Changes in morbidity rates for all age and diagnostic categories were compared with changes in weekly  $\text{SO}_2$  and smoke levels for the 9 weeks of the period of the pollution episode; similar analyses were applied to the comparator periods in which the equivalent week to the polluted week was used as the comparator week for assessing both within- and between-year differences.

As a separate exercise, weekly levels of  $\text{SO}_2$  and smoke were correlated with weekly mortality rates for the

same week and the following and subsequent weeks for all three periods under study and correlation coefficients obtained.

## Results

### Pollution Data

The mean daily level of  $\text{SO}_2$  recorded for the week of the pollution event was  $104 \mu\text{g}/\text{m}^3$  in the polluted area and  $72 \mu\text{g}/\text{m}^3$  in the nonpolluted area (Fig. 2). Equivalent levels for the two comparator periods were 66 and  $49 \mu\text{g}/\text{m}^3$  in 1983/1984 and 49 and  $33 \mu\text{g}/\text{m}^3$  in 1985/1986.

Smoke levels showed no consistent pattern for any of the three periods reaching weekly values in the polluted area of 38, 45, and  $23 \mu\text{g}/\text{m}^3$  for the polluted week or its equivalent for 1983–1984, 1984–1985, and 1985–

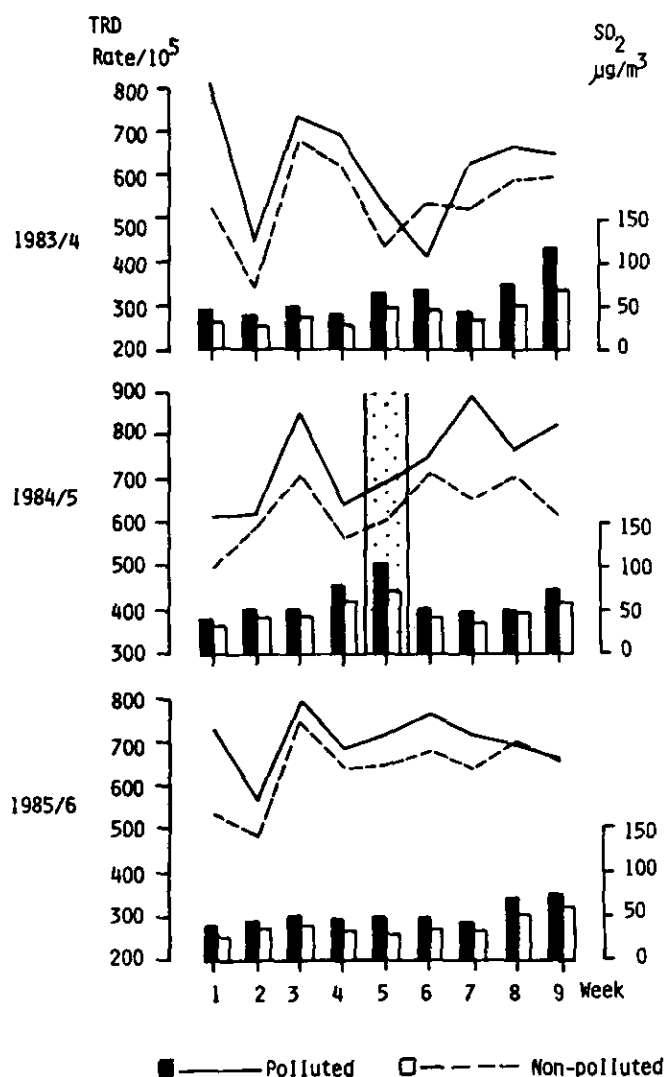


FIGURE 2. Rates for total respiratory disease (per 100,000) and weekly  $\text{SO}_2$  levels ( $\mu\text{g}/\text{m}^3$ ) for the three study periods in polluted and nonpolluted areas. [.] represents the week of the pollution event.

1986, respectively. Equivalent values for the nonpolluted area were 31, 32 and 17  $\mu\text{g}/\text{m}^3$ , respectively (Table 2).

## Respiratory Morbidity

**Populations.** There were no significant differences in the size of populations at risk in the overall 9-week period in each of the three study periods (Table 3). The variation between weeks within each study period was of the order of 9% for both polluted and nonpolluted areas. Over the Christmas/New Year period, more nonreturns occur, a pattern consistent from year to year.

**Total Respiratory Diseases.** Rates for TRD were similar for each of three periods under study (Fig. 2). There was no difference in the pattern of recording of TRD between the polluted and nonpolluted areas during the three study periods when considering all ages together (Fig. 2). Age-specific rates showed a marked rise in the 5 to 14 age group and also, to a lesser degree, in the 0 to 4 age group. This appeared to coincide with the arrival of the pollution cloud in the year of the pollution episode, but was seen in both polluted and nonpolluted areas for 1984–1985 (Fig. 3) and in the comparator years of study (Fig. 4).

**Acute Bronchitis and Acute Asthmatic Episodes.** The data for each of these two diagnostic categories were analyzed separately, but no rise was seen during the polluted week, in any age group, for either diagnosis. There were no differences either between polluted and nonpolluted areas or between the three study periods.

**Correlation Between  $\text{SO}_2$ , Smoke, and Respiratory Morbidity.** There was no correlation between  $\text{SO}_2$  levels and TRD morbidity rates for all ages (for the same week  $r = 0.192$ ; for the following week  $r = 0.292$ ; and for the second subsequent week  $r = 0.389$ ).

## Discussion

Using the data bases available, we have failed to show an increase in respiratory morbidity due to the acid

transport event of January 1985. Although there seemed to be a marked rise in rates in children at about the time of the pollution event, the rise occurred in both polluted and nonpolluted areas and in all three study periods. This rise coincided with the return of children to school after the winter vacation and probably represents rapid spread of viral infections in school. The slight rise in morbidity rates in the nonpolluted area during the week of the pollution event in 1984–1985 was probably due to the difficulty in defining accurately the polluted and nonpolluted areas. Extending the area of the polluted region would have reduced the number of practices in the nonpolluted area, possibly to a level where the low number of practices in that area would be likely to confer significant bias on the results. Nevertheless, there was a sufficient difference between the levels of pollutants in the two areas to hope that any difference in morbidity signal might be detected. However, there are a number of other factors that could have combined to result in this lack of positive finding.

First, the January 1985 pollution event was not particularly marked and occurred on top of background levels of pollution which were lower over the year as a whole than in previous years. For instance, in 1981–1982, there was a much greater rise in  $\text{SO}_2$  emission in January (1). Higher rates for acute bronchitis were recorded in the first quarter of 1982 (unpublished data), but the reasons for this are likely to have been multifactorial. The year 1982 was particularly cold, with considerable snowfall (thus enhancing transport of  $\text{SO}_2$  over longer distances), and other meteorological factors at that time were more conducive to the accumulation of pollution than in 1985. During such weather more domestic coal is burned, but the difference between 1982 and January 1985 was that the latter time period was affected by the coal miners' strike in the UK, which resulted in a marked reduction in the amount of domestic coal burned.

Second, the middle weeks of January are the weeks of the year with the highest respiratory morbidity and mortality in the UK. Consequently, it would have been surprising to have shown a further rise in respiratory illness as a result of a relatively small pollution event.

Table 3. Mean daily values for each week of three study periods for  $\text{SO}_2$  and smoke.

Week	1983/1984				1984/1985				1985/1986			
	$\text{SO}_2^a$		Smoke <sup>a</sup>		$\text{SO}_2$		Smoke		$\text{SO}_2$		Smoke	
	P <sup>b</sup>	N <sup>c</sup>	P	N	P	N	P	N	P	N	P	N
1	46	30	19	20	42	34	15	12	42	29	17	13
2	41	28	13	10	52	43	37	34	48	38	32	24
3	50	38	22	19	52	43	28	26	54	39	30	26
4	40	30	12	10	80	61	55	44	49	34	16	13
5	66	49	38	31	104	72	45	32	49	33	23	17
6	70	48	42	30	54	42	25	22	49	36	26	24
7	44	34	18	14	49	36	19	15	45	35	20	16
8	76	53	43	29	52	48	19	17	73	52	39	26
9	118	67	57	40	75	58	32	29	75	59	32	23

<sup>a</sup> $\text{SO}_2$  and smoke in micrograms per cubic meter.

<sup>b</sup>R, polluted.

<sup>c</sup>N, nonpolluted.

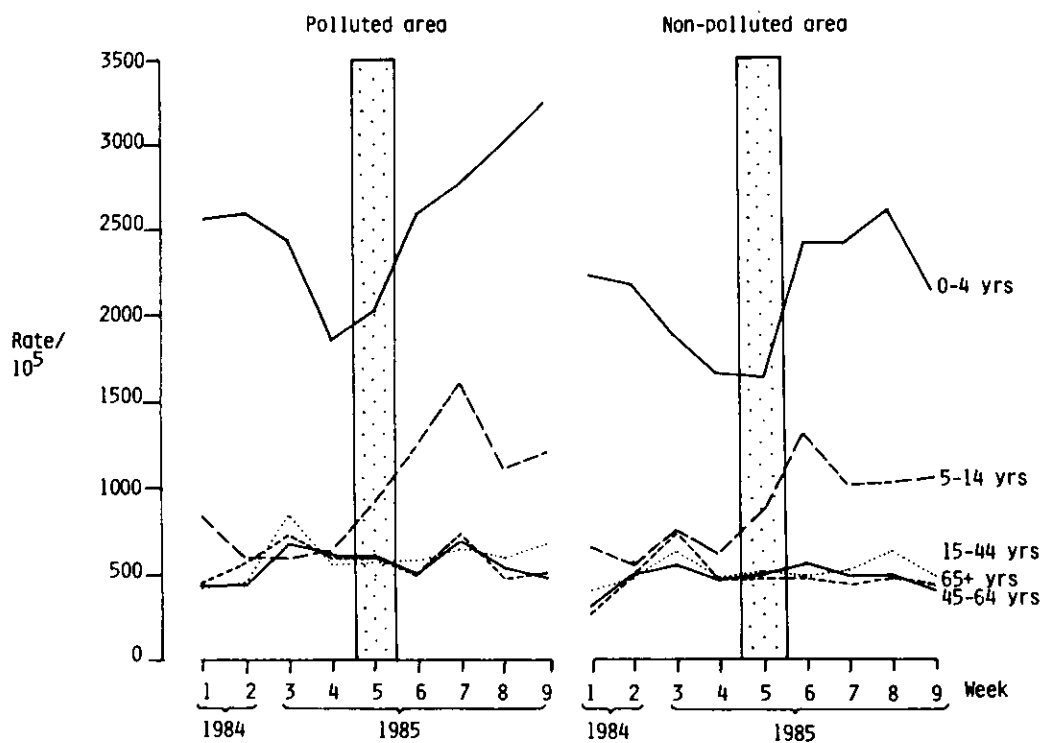


FIGURE 3. Age-specific rates (per 100,000) for TRD for the polluted and nonpolluted areas for 1984/1985.

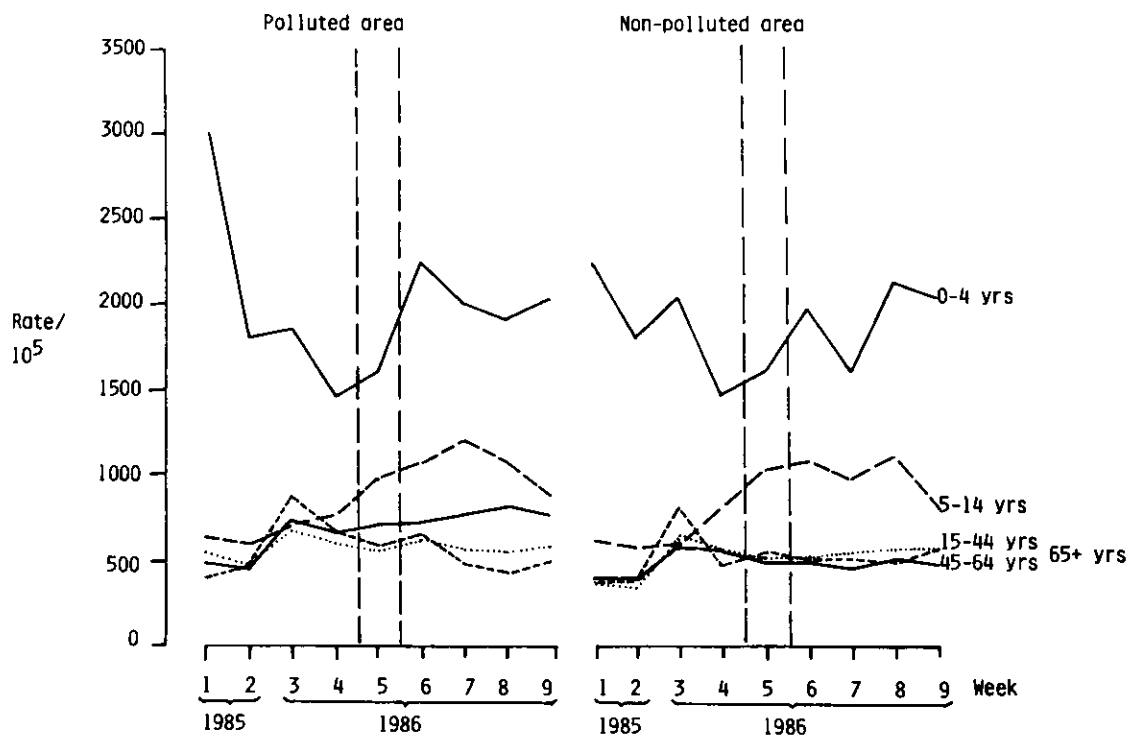


FIGURE 4. Age-specific rates (per 100,000) for TRD for the polluted and nonpolluted areas for 1985/1986.

Third, the weekly returns morbidity data are not available on a daily basis. This pollution event, although occurring fortuitously within one complete recording week of the weekly returns system, was largely over within 3 days, so any irritant effects or asthmatic attacks would have been likely to have been seen by the general practitioner in the early part of the week. The summing of the data over the whole of a week would have missed any early peak that may have occurred.

Finally, despite the fact that the density of pollution monitoring stations in the UK network is remarkably high, probably one of the most extensive for such a small area worldwide, there were often considerable distances between general practitioner offices with their attendant population and the nearest pollution monitoring site. In addition, the polluted area was largely over the central and eastern parts of the UK, where the density of recording practices is low, particularly over East Anglia. This compounds the problem of deciding upon the exact area the pollution cloud covered. It is possible, therefore, that there was a slight increase in respiratory morbidity during this event, but our data were not sensitive enough to detect it.

Measurement of morbidity from respiratory illness has always been difficult. Since the advent of self-certification for absence from work due to sickness in the UK a few years ago, the use of assessment of days lost from work as a measure of morbidity is only possible in individual population studies. For children, no data are kept in adequate form for days of lost schooling. Hospital admissions, using Hospital Activity Analysis (HAA), could be monitored, but for short-lived and relatively minor episodes such as the pollution event considered here, the data are too limited. The Weekly Returns System of the Royal College of General Practitioners Research Unit is a unique data source, which, although covering only a relatively small population at risk compared to the total population of the UK, is representative of the distribution of the UK in terms of urban to rural areas and coastal areas to those inland. There are plans to extend the network to cover a population of around 400,000 (70 practice sites). This would improve the validity of future planned studies of monitoring the effect of airborne pollution in the UK on respiratory morbidity, incorporating the two data sources used in this paper. Although we were unable to find any significant correlation between weekly pollution levels and morbidity rates, this may have been in part due to these geographical problems,

although the weekly nature of the morbidity data will of necessity reduce its sensitivity. More extensive analysis incorporating a wider range of pollution levels and respiratory morbidity, i.e., over a whole year or years, might yield significant associations, and such an analysis is underway. This should not deter our further use of these two data sets in combination, however, as we believe that, allowing for the problems, we have a unique system for assessing the effects of pollution on respiratory morbidity in the UK. To date we have only been able to divide the weekly returns data geographically into a maximum of three broad regions (8), as smaller areas would contain too few practice sites, perhaps with a preponderance of single-handed general practitioners when individual diagnostic preferences might begin to confer significant bias on the results. With a larger network this source of bias would be reduced when considering smaller geographical areas.

There has been little pollution research in the UK concerning respiratory morbidity over the past two decades. Future use of these data sources can now form the basis of research into the effect of environmental factors on respiratory morbidity in the community in the UK.

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